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Measuring Market Conduct in the Brazilian Cement Industry: A Dynamic Econometric Investigation

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Measuring Market Conduct in the Brazilian Cement Industry: a Dynamic Econometric Investigation*

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Abstract

Indirect assessments of market conduct have become widespread in the New Empirical Industrial Organization-NEIO literature. Recently, Steen and Salvanes (1999) provided a flexible dynamic econometric formulation of the approach advanced by Bresnahan (1982) and Lau (1982). The present paper considers a similar approach as applied to regional cement markets in Brazil under more favorable data availability and it also attempts to address part of the critiques that usually emerge with respect to the NEIO literature. In particular, issues pertaining structural stability and yet the control for the number of competing firms are addressed. The evidence clearly indicates non-negligible and distinct market power in the different regions and yet distinct conduct patterns in the short and long-run.

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1. Introduction

Empirical assessments of market conduct in the context of unobservable marginal costs have become widespread in the recent empirical literature. The corresponding identification of the conduct parameter either relies on the responsiveness of prices to changes in the elasticity of demand or shifts in costs [see e.g. Bresnahan (1989) for an early account on the so-called New Empirical Industrial Organization-NEIO].

The aforementioned methodologies, however, have been questioned with respect to the accurateness of the indirect conduct measurement. At an empirical level, works by Aiginger (1995) and Steen and Salvanes (1999) defended the possible gains of implementing flexible and dynamic empirical specifications despite the usual underlying static oligopoly framework. Those approaches attempt at capturing short-run dynamics and implicitly account for dynamic effects that could be related to habit formation in demand and adjustment costs in supply.

Many criticisms have surfaced with regard to NEIO models as exemplified by Corts (1999), Sexton and Zhang (2000), Puller (2002) and Kim and Knittel (2004), and range from the empirical definition of the relevant market to theoretical considerations over the validity of the conduct parameters estimated. In a related vein, direct robustness investigations were undertaken in contexts where a simple technology prevailed and related cost information was available, and provided favorable support to the NEIO approach [see Genesove and Mullin (1998) and Clay and Troesken (2003)].

The purpose of the present paper is to address some of the concerns related to the NEIO literature by considering a dynamic econometric model in a more favorable context in terms of data availability. In particular, issues pertaining structural stability and yet the control for the number of competing firms are addressed. We consider the Brazilian cement industry, with the motivation of good data availability and the possibility of different regional estimates. This traditional homogeneous oligopoly has been studied extensively [see e.g. Lima (1995), Steen and Sørgard (1999), Rosenbaum and Sukharomana (2001), Roller and Steen (2003), la Cour and Møllgaard (2003), and Salvo (2004)], and this also allows for solid comparison of the estimates.

The paper is organized as follows. The second section introduces basic background to motivate the empirical model to be estimated. The third section provides details on the cement sector. The fourth section presents the empirical analysis in terms of the data construction, the formulation of the empirical model and related estimates. The fifth section brings some final comments.

2. NEIO Models: Basic Conceptual Aspects

2.1- Introduction

A typical approach for identifying the conduct parameter in oligopolistic markets relies on the responsiveness of prices to changes in the elasticity of demand [see e.g. Bresnahan (1989)]. Seminal conceptual contributions associated with that approach include Bresnahan (1982) and Lau (1982). A starting point is to conceive a generic perceived marginal revenue that depends on the conduct parameter θ as given by MR(θ) = p + θ Q dp/dQ, where p and Q respectively denote price and quantity Under profit maximization such expression is to be equated to the marginal cost and three important cases arise as particular cases. If θ = 1 it corresponds to a fully collusive situation. Other salient polar case occurs θ = 0 as would be the case in a competitive market. The intermediate range of the conduct parameter would include different degrees of imperfect competition, in particular θ = 1/n would be consistent with a symmetric Cournot oligopoly with n firms

Under the aforementioned framework the rotation of demand by means of the inclusion of an interaction term plays a decisive role on the identification of the conduct parameter in a homogeneous oligopoly. The argument advanced by Bresnahan (1982) and Lau (1982) is by now well established and the demand function and supply relation are given respectively by:

$$Q_i = \alpha_{0i} + \alpha_P P_i + \alpha_Y Y_i + \alpha_Z Z_i + \alpha_{PZ} P Z_i \ + \varepsilon_i \qquad (1)$$

and:

$$P = \beta_{0i} + \beta_{Qi} Q_i + \beta_{W1i} W_{1i} + \beta_{W2i} W_{2i} + \beta_{W3i} W_{3i} - \theta\, s\, Q_i^* + \eta_i \qquad (2)$$

with: $Q^* = \dfrac{Q}{\alpha_P + \alpha_{PZ}}$

A departure from the bulk of the static version of the NEIO model is provided by Karp and Perloff (1989), Deodhar and Sheldon (1996), Aiginger (1995), and Steen and Salvanes (1999). The last two works, in particular, considers a flexible (error correction) dynamic specification for non-stationary variables. This paper closely follows Steen and Salvanes (1999) specification.

At a conceptual level, it is important to stress that NEIO models essentially relied on static oligopoly models. The flexibilization implied by the empirical dynamic model is therefore mostly justified on the grounds of the capability of properly capturing short-run departures from long-run equilibrium rather than a strict adherence to the underlying (static) theoretical model in the context of non-stationarity.

Since a dynamic version should give more information about the market, the approach we will take in developing a NEIO model for the Brazilian cement market will incorporate two versions, one static and one dynamic. Following Steen and Salvanes (1999) ECM model, the modified demand becomes:

$$\Delta Q_t = \alpha_0 + \sum_{i=1}^{k-1} \alpha_{Q,i} \Delta Q_{t-i} + \sum_{i=0}^{k-1} \alpha_{P,i} \Delta P_{t-i} + \sum_{i=0}^{k-1} \alpha_{z,i} \Delta Z_{t-i} + \sum_{i=0}^{k-1} \alpha_{pz,i} \Delta PZ_{t-i} +$$
$$+ \gamma^* [Q_{t-k} - \theta_p P_{t-k} - \theta_z Z_{t-k} - \theta_{zp} PZ_{t-k}] + \varepsilon_t, \qquad (3)$$

where: $\theta_j = \dfrac{\alpha_j^*}{\gamma^*}, \; and \;\; j = P, Q, Z, PZ$ with P, Q and Z respectively indicating price, quantity and a demand shifter, whereas the variable PZ reflects an interactive term associated with the rotation of the demand necessary for the conduct parameter identification. The existence of an error correction representation follows the Granger representation theorem (1981). The result legitimates such representation in the context of non-stationary cointegrated *I(1)* variables.

The Bärsden (1989) transformation ECM is given by:

$$\gamma^*[Q_{t-k} - \theta_p P_{t-k} - \theta_z Z_{t-k} - \theta_{zp} PZ_{t-k}]$$

and θ_p is the long-run effect of P on Q.

The supply relation is transformed to:

$$\Delta P_t = \beta_0 + \sum_{i=1}^{k-1} \beta_{p,i} \Delta P_{t-i} + \sum_{i=0}^{k-1} \beta_{Q,i} \Delta Q_{t-i} + \sum_{i=0}^{k-1} \beta_{w,i} \Delta W_{t-i} + \sum_{i=0}^{k-1} \theta_S \Delta Q^*_{t-i} +$$
$$+ \psi^*[P_{t-k} - \xi_Q Q_{t-k} - \xi_W W_{t-k} - \Lambda Q^*_{t-k}] + \eta_t, \qquad (4)$$

where: $Q^*_i = \dfrac{Q_t}{(\theta_P + \theta_{PZ} Z_t)}$, and:

$$\theta_L = \frac{\theta_S{}^*}{\psi^*}, \xi_Q = \frac{\beta^*_Q}{\psi^*}, \xi_W = \frac{\beta^*_W}{\psi^*}$$

The price-elasticity of demand (ε_{pp}) and income-elasticity (ε_{pz}) are calculated in the usual way:

$\varepsilon_{pp} = [\alpha_p + \alpha_{pz} \bar{Z}].[\bar{P}/\bar{Q}]$ and $\varepsilon_{pz} = [\alpha_p + \alpha_{pz} \bar{P}].[\bar{Z}/\bar{Q}]$

The static conduct parameter θ_s and the long-term parameter θ_L appear in equation (4). The rationality is that in the dynamic version there is a static measure of market power, with an error correction mechanism that drives the market towards equilibrium in the long run and Ψ^* is the adjustment parameter of the supply relation – 0 indicates permanent deviation from the short-run equilibrium and 1 is instant adjustment

The empirical analysis follows three steps:

a) Consider unit root tests and verify the prevalence of cointegration in the case of I(1) variables, where the lag structure of the VAR system should be justified in terms of some established criterion (say Akaike information criterion);
b) Generate (lagged) residuals of the VAR estimation to be used as an error correction term in the related representation (assuming cointegration)
c) Estimate equations (3) and (4) by means of two stage least squares

2.2- Critiques to NEIO Models

Critiques to NEIO models can be summarized as follows [see e.g Corts (1999), Sheldon and Zhang (2000), Puller (2002) and Kim and Knittel (2004)]:

i) Weak economic theory foundation

Since NEIO models can be related to a conjectural variations framework, an indirect critique to NEIO models is that "one aspect that has been discussed critically pertains the conceptual underpinning or lack thereof provided by the conjectural variations framework."[1] A partial caveat on that critique is motivated by the work of Cabral (1995) that has shown that the conjectural variation model can be seen as a reduced form for a simultaneous quantity-setting Cournot supergame in the case of a linear demand. In other words, under certain conditions the conjectural variation framework provides an approximation for a dynamic model.

[1] See Sexton and Zhang, (2000), p. 19.

ii) No treatment of structural changes such as technology

One very pertinent critique (Sexton and Zhang, 2000) is that most NEIO studies have relied on yearly data. To gain enough data points, in some cases NEIO models have been estimated with data that spans 30-years, without allowing for structural changes or even doing that through simple dummy variables. Again, this is not a critique of NEIO models per se, but of specification of empirical models used in industrial economics.

iii) Difficulties in defining the relevant market definition

Another critique not applied only to NEIO models is that of relevant market definition. Schroeter (1988), for instance, defines the beef market as national, even though cattle are seldom shipped as far as 300 miles (Sheldon and Zhang, 2000).

iv) Ad hoc hypothesis on demand and supply variables

Most of NEIO estimation was undertaken in the context of one-sided market power, i.e., it assumes that market power occurs only on one side of the market, and the other side behaves competitively. This may not be the case, with markets with market power on demand and supply sides. Some studies [Schroeter et al (2000); Gohin and Guyomard (2000)) have dealt with it using models that allow market-power on demand and supply.

v) Inconsistency of the conduct parameter

The most challenging critique of NEIO models is that of Corts (1999). The author observes that any structural change on demand or supply variables would make the conduct parameter correlated with the instrumental variables necessary for the estimation of the model. Furthermore, Wolfram (1999), Corts (1999) and Puller (2002) show that if the firms are efficiently colluding, the model estimated is misleading since there is no simultaneous quantity-setting and the conduct parameter estimated would understate the true conduct parameter. As a result, the model would be only useful to test if the market behaves competitively (θ=0), monopolistically (θ=1), or would have a Cournot-equilibrium (θ=1/n, where n is the number of firms on the market). In the next sections we detail the empirical implementation of the present paper.

3. The Cement Oligopoly

3.1- The Brazilian cement market**.**

The cement industry is commonplace in industrial empirical studies because it is considered an archetype homogenous oligopoly. This has the benefit of allowing comparisons with the results of many other studies. In fact, cement is almost completely a homogeneous product, which allows for a simple specification of the demand function and supply relation.

Also, the cement production involves economies of scale – BNDES (1995); large distribution costs – 94.5% of the cement consumed is produced within a 300 mile radius (Rosembaum and Sukharomana, 2001); and a short shelf-life – which does not allow large inventories and makes market interactions much more rapid and quantity-setting the norm for firm decision. The industry is mature, with few technological improvements, the last important one being the introduction of the dry production process in the 70´s (Teixeira *et alli*, 2003).

Finally, it is worth mentioning that the Brazilian cement market is highly concentrated, with Votorantim leading the market with 41.5% in 2002

INSERT TABLE 1 HERE.

An aggregate CR4 index, however, would bring little information on the market structure due to the spatial distributions of firms and markets - Brazil is the 5th largest country in the world and cement has large distribution costs. Brazil has five major regions – Southern, Southeast, Northern, Northeast, and Midwest. Not every firm is present in every region, and for the purposes of this paper, we will assume that the relevant market is a regional one[2].

INSERT TABLE 2 HERE.

The table reveals the spatial distribution of Brazilian firms. Although the data is only for year 2002, this distribution has been the same for the last ten years, with no new entries or exits in the regional markets. The Northern region has only one firm with two industrial units[3], while the Southeast (and richest) region have 29 industrial units with 8 firms present. Also, the demand for cement

[2] This is supported by a vast literature on the brazilian cement market. (Haguenauer, 1997; Lima, 1995; BNDES, 1995; Teixeira *et alli*, 2003). Salvo (2004), however, estimates a model with a state regional market. The problem with this is that Brazil has 23 states and inter-state trade among frontier states is very relevant to total state consumption, comprising more than 60% in some cases (Sindicato Nacional da Indústria de Cimento – SNIC, various years).
[3] It should be noted that although cement is considered a non-tradeable, imports can happen in frontier regions. In Brazil's case, imports only happen on the Northern and Midwest regions, which may restrain some market-power of those concentrated markets.

is pulverized and we can safely assume that there is no market power on the demand side. This is also supported by the Brazilian cement literature (Cunha and Fernandes, 2003). Also, vertical integration is not a relevant concern to two-sided market-power and is mainly used to reduce costs in the few instances it happens (Teixeira et al (2003)).

INSERT TABLE 3 HERE.

3.2- Meeting the Critiques.

Although most critiques are not directed only to NEIO models, they are still pertinent to the empirical models being estimated. We believe that the chosen sector enables a more favorable application of the NEIO framework and motivate next how some previous concerns are lightened. The NEIO model applied to the Brazilian cement market will use monthly data that spans 10 years. In this time-frame no major technological improvement has occurred (Cunha and Fernandes, 2003) and extra care will be exercised with the consideration of tests for structural breaks. Thus the concerns related to two critiques can be dampened: using monthly data is probably the first choice of empirical estimation, and the fact that the market has not had major structural changes allows for an unbiased estimation.

In relation to the relevant market critique, there is support in the literature for a Brazilian regional market[4]. To account for it, the estimation is done to each region separately, with a conduct parameter for each region.

The market power is clearly one-sided, with a pulverized demand (shown in table 3) that only allows market power on the supply side. Also, the functional forms used in estimation, all linear, have support on Genesove and Mullin (1998).

Corts (1999) critic is also an empirical one. It involves mainly the fact that there is a possibility that the conduct parameter presents correlation with the instrumental variables used in the estimation, which transforms the conduct parameter into an endogenous variable of the system, and thus not explicitly identifiable. What we propose is a structural change test to identify changes (if any) in the demand function and supply relation which would turn the conduct parameter into an endogenous variable. The rationality is that, if the conduct parameter is exogenous and constant no structural changes in the market occur and the conduct parameter is identifiable and unbiased, and thus Corts (1999) critic is met. It should be noted that neither Steen and Salvanes (1999) nor Nakane (2002) – the two studies that used the Bärsden (1989) transformation to incorporate an ECM into a NEIO model – have undertaken a structural change test.

[4] There may be doubts as to whether Brazil's five regions is the best relevant market, or states should be grouped in other non-conventional regions (maybe 6 or 7 regions). However, as any other grouping would be as ad hoc as the 5 region grouping, and this grouping has support in the literature, no other test for best grouping were taken.

The main critic that is theoretical in nature, that of the validity of the conduct parameter, is harder to meet. It involves theoretical aspects of industrial economics models and its discussion is not in the scope of this work. For simplicity, it is assumed that conjectural variance models are a valid way of estimating market power. The other theoretical critic, that of the validity of a pure econometric version for a NEIO model as the one constructed by Steen and Salvanes (1999) is going to be discussed in the section where the results for the conduct parameters are presented.

4. Empirical Analysis

4.1- <u>Data Construction</u>

The essential ingredients of any NEIO study are price, quantity, demand and cost shifters. Quantity prices at each state were obtained from the Brazilian manufacturers' association {Sindicato Nacional da Indústria do Cimento-SNIC} on a monthly basis, whereas prices for cement and relevant inputs in each state were obtained from the Brazilian statistical bureau [SIDRA-IBGE]. Data spans 12 years (1991/2002), with 144 data points. The data is complete to all regions in the period considered. The descriptive statistics are presented in Appendix 1. As we considered the relevant market as regional, aggregations were undertaken.

Q: growth of consumption of Portland cement in tons. for the given region. The quantity in each region is readily obtained upon the state figures;

P: growth of price of the Portland cement (CP-32 50kg). The regional price is obtained as a weighted average of the median price at each state where the weights are given by the quantities. The prices are deflated by the general price index (IGP from IBGE).

W_i: The supply instruments are costs instruments from cement production: wages (W_1), price of calcareous materials (chalk) (W_2), and price of sand used in cement production (W_3). Wages is the hourly wage of the cement industry worker. Calcareous materials and sand are prices per kilogram.

Y: monthly GDP[5].

Z: index for the construction industry activity.

4.2- <u>Empirical Model</u>

Before the estimation for the static and dynamic versions several tests were undertaken. Tests for unit roots revealed that the variables were I(1) processes. Cointegration tests were also performed to ensure that a ECM formulation was possible. A separability test was necessary since Lau's (1982) impossibility theorem shows that only if the demand is separable the conduct parameter can be identified. A test to determine the lag of each variable was also performed based on Akaike (1979). All results are presented in the appendix.

Finally, to meet Corts (1999) critique and establish that the conduct parameters estimated are stable and could be considered unrelated to the variables in the estimation procedures two structural change tests have been used, the regular Chow test and the recursive Chow test. The first test separate the *T* observations in half, estimating two separate demand function and testing

[5] The model can be estimated with only one variable representing the Z variable (Steen and Salvanes, 1999). We chose another demand variable, Y, to improve the estimation, as many previous works did (Steen and Salvanes, 1999, Alexander, 1988).

for changes in the structure. The second test is more encompassing in nature: first it is estimated the demand function with *n* observations, with subsequent estimation of the demand function with *n+1, n+2, … T*. In both cases it is used a F-test statistic with an associated probability of structural stability. In the present work we conducted the test on the more general dynamic version of the demand function, since if there is a long-term stability derived from the dynamic version it is safe to assume the some from the static version. From

INSERT TABLE 4 HERE.

it can be concluded that for both tests the demand is structurally stable and thus the conduct parameter estimated can be considered an exogenous variable and thus an unbiased estimate of the average market-power of firms on the regional Brazilian cement market.

INSERT TABLE 4 HERE.

All the above mentioned tests confirmed that estimation of the static and dynamic versions was possible, since the variables were separable, had unit roots *I(1)*, and cointegration prevailed.

We summarize the relevant estimation results of both static and dynamic versions in table 5.

INSERT TABLE 5 HERE.

The two main parameters are θ_S and θ_L, and respectively denote the short-run and long-run conduct parameters[6]. The latter is estimated only in the dynamic version of the NEIO model. ε_{pp} and ε_{pz} are the price-elasticity and income elasticity of demand. Ψ^* is the adjustment parameter estimated in the dynamic version. The Cournot value is a comparative measure of the conduct parameter from symmetric Cournot oligopoly, which is 1/n, where n is the number of firms

In the first row there are the static and dynamic conduct parameters for both version of the NEIO model. It was expected that the parameters would be close if both specifications were the best ones for the market. In this case there is no difference between a short-run and a long-run equilibrium, since there is a new equilibrium each stage (in our case, a month). The average market-power found in the static version of the NEIO model is, then, the average result of the firms behavior in the market in the period considered. Although Steen and Salvanes (1999) find the dynamic version superior, we conclude that there is no *a priori* better version and thus we estimate both versions of the model[7].

[6] Short-run conduct parameter is a wrong definition for the conduct parameter estimated from the static version of the model. However, since the dynamic version has a short and long-run parameter conduct with the short-run conduct parameter having the same notation as the static conduct parameter, for the sake of simplicity we will call the conduct parameter of the static version a short-run conduct parameter.

[7] As also Steen and Salvanes (1999) did. However, they dismissed the static result saying that it did not fit expectations for the salmon market.

The results from both specifications do not present enough evidence to conclude that either one is a superior version. Comparing the short-run result of both versions, we find that in all regions the dynamic version's conduct parameter is less than the static version's. Also, the conduct parameters for the Midwest and Southern regions are particularly different - 0.880 and 0.739, respectively for the static version, with 0.127 and 0.217 for the dynamic version. Market power appears to be more significant in the static rather than in the dynamic version,

Moreover, two important conclusions are common to both versions of the model: the conduct parameters are different in each region which makes it clear that there is no national market ; and there is no perfect competition behavior in any regional market because no interval conduct parameter – static or dynamic – allows it, which is expected due to the fact that cement is considered an archetypical oligopoly. It is also important to notice that for most regions the conduct – in both static and dynamic versions of the model - is correlated to the number of industrial units– more units means that firms behave, on the average, more competitively. The exception is the dynamic short-run conduct parameter of the Midwest and Southern regions, where a parameter near 0 was not expected due to the fact that only 3 and 4 firms, respectively, are present on those markets. It is interesting to note that in the Northern region, with only one firms and two industrial units, neither the interval for the short-run conduct parameter of the static]0.957;0.701[and dynamic]0.670;0.268[versions, nor the interval for the long-run conduct parameter]0.785;0.379[of the dynamic version contemplate a monopolistic behavior. This is probably due to imports from neighbour countries like Venezuela – even though cement is usually a non-tradeable good, imports can happen in frontier regions.

It was expected that the estimated long-run conduct parameters of the dynamic version would be lower than the short-run parameters. Economic theory explains it on the basis firms behave collusevily in the short-run but there are not enough barriers of entry to prevent at least some competition on the long run. However, that was not the case for the Northern, Northeast and Midwest regions.

The Ψ^* adjustment parameter should be in the interval between -1 and 0 (Steen and Salvanes, 1999, p. 166). Thus a 0.978 adjustment parameter to the North region means a 97.8% adjustment after deviations from the long-run equilibrium in the supply relation. For the Southern and Midwest regions, however, Ψ^* is lower than -1, -1.644 and -2.509 respectively. There is no economic explanation for this overshooting.

The evidence is consistent with a Cournot equilibrium is present in the intervals for all the conduct parameters for the Northeast region, and the short-run conduct parameters of both static and dynamic versions for the Southeast region. This result is interesting as it is related to the strong analytical support for Cournot behavior on those markets. Also, the market where the firms behave more competitively is the Southeast region, with small conduct parameter for both versions, which is expected due to the fact that it is where most firms are present, 8, and is the richest region of Brazil, and thus naturally brings more competition. To test for Cournot equilibrium in both the Northeast and Southeast regions, we formulate a simple t-test (following Steen and Salvanes, 1999) with the null hypotheis $H_0 : \theta = 1/n$ and $H_1 : \theta \neq 1/n$. At a 5% significance level we accept the H_0 hypothesis for both markets and thus can conclude that Cournot equilibrium is the short-run solution for the Northeast and Southeast regions. The same test applied for the South and Middlewest regions, and a similar test for the North region with $H_0 : \theta = 1$ have resulted in the rejection of all the null hypothesis, which means that the North regions does not behave monopolistically nor Cournot equilibrium is a solution for the other regions.

Another important observation then is that the results for both versions of the models are robust for the Northern, Northeast and Southeast regions, with indefinite conclusion other than the presence of market-power for the Southern and Midwest regions. There is no definite conclusion on which version fits best the analytical framework of those markets, although the dynamic version gives interesting information of possible long-run collusion on the selected markets.

5. Final Comments

The main goals of this paper were to meet recent critiques to NEIO models and improve empirical procedures to NEIO models to verify its robustness.

Most NEIO critiques are related to the estimation procedures, and thus could be met because the estimation procedures for the Brazilian cement regional markets were done under a much more favourable scenario in terms of data availability. Also, determining a regional relevant market and estimating conduct parameters for each region gave better insights than a single parameter could.

To meet the most challenging critique, that of Corts (1999), a structural change test was considered. The evidence indicates that no structural change occurred in any region for the selected period and thus those parameters could safely be considered exogenous and uncorrelated with the instruments used to estimate it.

Two versions – one static and another dynamic – of the model were estimated. It was found that for every region the short-run static conduct parameter was larger than either the short-run or long-run dynamic conduct parameter, with the exception of the long-run conduct parameter for the Northeast region.

Using regional markets was important because it allowed for good comparisons of the results, with a potentially more collusive behavior being expected in regions with less firms operating. The results are consistent with those expectations for the most part. The conduct parameters were higher in the Northern region – where only one firm operates, while in the Southeast region, with the larger number of firms operating, all conduct parameter were indicative of a smaller degree of market power as compared to the other regions. It should be noted that all conduct parameters indicated non-negligible market power in all the regions, as expected for an archetypical oligopoly market such as cement.

It is important to notice that there are no indications that the dynamic specification is the superior one, as would be normally expected (Steen and

Salvanes, 1999). All results from the static and dynamic specification are consistent with a significant market power and are, for the most part, in direct correlation with the number of firms operating in each region. Interestingly, some results are compatible with a Cournot equilibrium – specifically, both short-run equilibrium for the static and dynamic versions for the Northeast and Southeast regions.

Possible extensions in terms of similar frameworks relate to at least three research lines. First, one should consider an explicitly dynamic theoretical model that would provide sound foundations for the flexible empirical approach considered in this paper. Second, similar developments for the case of differentiated oligopolies would be pertinent and the work of Nevo (1998) could be a useful starting point. Finally, one should be interested not only in detecting the prevalence of market power but also in identifying its source. In that sense, the association of the conduct parameter with other relevant variables through a latent structure could be relevant [see e.g. McCluskey and Quagrainie (2004)]. All those avenues of research, however, extrapolate the scope of the present paper and are therefore left for future research.

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Table 1 – The Brazilian National Cement Market – 2002 – tons.

Company	2002 ton	% in 2002
Votorantim	15.773.818	41,5%
Nassau	4.704.709	12,4%
Cimpor	3.761.539	9,9%
Holcim	3.316.283	8,7%
Camargo Côrrea	3.056.974	8,0%
Lafarge	2.660.662	7,0%
CP–Cimento	1.942.230	5,1%
Soeicom	1.115.731	2,9%
Itambé	884.910	2,3%
Ciplan	810.460	2,1%
Total	38.027.316	100,0%

Font: SNIC, 2002.

Table 2 - The Brazilian Regional Cement Market – 2001/02 – tons.

Industrial Companies	2001	2002	% 2002	Ind. units
Northern				
Nassau	1.183.077	1.188.445	100,0%	2
TOTAL NORTHERN	1.183.077	1.188.445		2
Northeast				
Nassau	2.072.391	2.289.506	31,2%	6
Votorantim	3.406.684	3.324.786	45,3%	3
Lafarge	364.477	121.073	1,6%	1
Cimpor	1.396.834	1.610.792	21,9%	4
TOTAL NORTHEAST	7.240.386	7.346.157		14
Midwest				
Votorantim	2.142.641	2.065.152	50,8%	3
Ciplan	735.699	810.460	19,9%	1
Camargo Côrrea	511.666	463.056	11,4%	1
Cimpor	730.569	730.194	17,9%	1
TOTAL MIDWEST	4.120.575	4.068.862		6
Southeast				
Votorantim	6.065.857	5.678.227	29,7%	7
Nassau	1.272.971	1.226.758	6,4%	1
Cimpor	669.626	657.341	3,4%	1
Holcim	3.514.554	3.316.283	17,4%	5
Camargo Côrrea	2.732.073	2.593.918	13,6%	4
Lafarge	2.703.485	2.539.589	13,3%	6
Soeicom	1.143.901	1.115.731	5,8%	1
CP – Cimento	2.012.737	1.942.230	10,2%	4
TOTAL SOUTHEAST	20.115.204	19.109.258		29
Southern				
Votorantim	4.680.141	4.705.653	74,5%	4
Cimpor	721.636	724.031	11,5%	2
Itambé	877.463	884.910	14,0%	1
TOTAL SOUTHERN	6.279.240	6.314.594		7
Total Brasil	38.938.482	38.027.316		58

Fonte: SNIC, 2002.

Table 3 – Cement consumer profile in 2002 - % of total consumption.

		Consumer	North	Northeast	Middlewest	Southeast	South	Avrge
	1	Individuals Distributors	83.91%	79.37%	71.60%	67.87%	62.62%	70.33%
	2	Industrial Consumers	10.35%	10.03%	17.87%	24.96%	31.01%	21.80%
i		Concrete Firms	6.57%	6.98%	11.81%	14.98%	15.28%	12.82%
ii		Fibrocement	2.81%	0.45%	2.58%	1.79%	6.54%	2.47%
iii		Pre-Mold	0.73%	2.09%	1.69%	3.37%	2.57%	2.70%
iv		Other	0.23%	0.52%	1.79%	4.83%	6.63%	3.81%
	3	Final Consumers	5.75%	10.60%	10.54%	7.16%	6.36%	7.87%
i		Real estate developers	5.75%	10.57%	10.00%	6.98%	6.23%	7.70%
ii		State and Federal	0.00%	0.02%	0.31%	0.15%	0.11%	0.13%
iii		Municipalities	0.00%	0.00%	0.22%	0.03%	0.03%	0.04%
Total			100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

Font: Cunha and Fernandez, 2003.

Table 4 – Results for the two Chow Structural Change tests.

Region	Regular Chow		Recursive Chow	
	F-test	P-value	F-test	P-value.
Northern	0.015172	0.999916	0.0000977	0.992128
Northeast	0.017190	0.999885	0.0010160	0.974623
Southeast	0.000116	1.000000	0.0000066	0.997946
Southern	0.004281	0.999996	0.0001170	0.991395
Midwest	0.000372	1.000000	0.0000073	0.997850

Table 5 – Relevant results of static and dynamic versions of a NEIO model applied to the regional cement markets in Brazil.

	Northern		Northeast		Southeast		Southern		Midwest	
	static	dynamic	static	dynamic	static	dynamic	static	dynamic	static	dynamic
θ_s	0.829	0.469	0.303	0.188	0.213	0.095	0.739	0.217	0.880	0.127
st.dev.	(0.128)	(0.201)	(0.082)	(0.065)	(0.101)	(0.072)	(0.105)	(0.028)	(0.098)	(0.045)
p-value.	0.023	0.001	0.031	0.004	0.041	0.011	0.018	0.009	0.038	0.021
θ_L	-	0.582	-	0.361	-	0.057	-	0.154	-	0.448
st.dev.	-	(0.203)	-	(0.102)	-	(0.022)	-	(0.031)	-	(0.070)
p-value.	-	0.012	-	0.031	-	0.018	-	0.002	-	0.012
ε_{pp}	-0.103	-0.274	-0.139	-0.069	-0.471	-0.098	-0.184	-0.106	-0.518	-0.622
ε_{pz}	0.498	0.131	1.223	0.914	0.831	0.742	0.302	1.648	0.601	0.650
Ψ^*	-	-0.978	-	-0.486	-	-0.373	-	-1.644	-	-2.509
R^2 *aj.dem*	0.445	0.914	0.524	0.816	0.679	0.935	0.518	0.754	0.409	0.638
R^2 *aj.sup*	0.568	0.817	0.603	0.659	0.622	0.764	0.604	0.717	0.436	0.558
Cournot	1.000	1.000	0.250	0.250	0.125	0.125	0.333	0.333	0.250	0.250

Appendix 1 : Summary statistics.

Region	Variable	P	Q	W_1	W_2	W_3	Y	PZ	Z
Northern	Mean	19.463	119,733	2.764	17.507	0.461	3,141,768	1,881	103.870
	Min	14.537	53,423	2.200	14.423	0.343	2,669,001	1,468	79.038
	Max	24.887	220,555	3.606	22.609	0.621	3,922,982	2,366	133.950
	St-Dev	1.399	45,732	0.231	1.290	0.039	317,885	186	11.171
	Var	1.958	$2,091*10^6$	0.053	1.663	0.002	$10,105*10^6$	34,435	184.791
Northeast	Mean	18.297	444,493	3.337	21.788	0.355	3,164,485	1,769	100.453
	Min	13.888	217,465	2.552	16.917	0.268	2,946,202	1,309	70.453
	Max	24.634	1,071,275	4.663	28.944	0.471	3,922,982	2,382	117.532
	St-Dev	1.657	143,748	0.320	1.659	0.029	178,042	199	13.160
	Var	2.744	$20,663*10^6$	0.102	2.751	0.001	$31,698*10^6$	39,657	144.693
Southeast	Mean	18.117	1,510,668	5.242	31.808	0.221	3,557,808	1,751	99.432
	Min	14.382	923,010	4.109	27.527	0.185	3,378,829	1,342	72.723
	Max	23.891	2,038,296	6.739	40.105	0.277	4,376,456	2,168	116.345
	St-Dev	1.430	309,137	0.409	2.199	0.015	198,654	176	11.618
	Var	2.045	$95,565*10^6$	0.168	4.835	0.000	$39,463*10^6$	30,977	154.121
Southern	Mean	16.937	463,252	3.762	24.017	0.160	3,668,924	1,636	97.075
	Min	14.599	311,814	2.703	20.952	0.124	3,475,883	1,250	69.260
	Max	23.538	630,072	4.766	30.178	0.231	4,525,276	2,007	123.950
	St-Dev	1.236	85,262	0.303	1.444	0.013	207,199	152	11.171
	Var	1.528	$7,269*10^6$	0.092	2.086	0.000	$42,931*10^6$	23,049	124.791
Midwest	Mean	17.546	222,415	3.744	30.525	0.224	3,164,485	1,695	98.668
	Min	14.398	127,857	2.982	26.016	0.121	2,946,202	1,271	70.652
	Max	32.345	339,000	4.862	39.622	0.368	3,922,982	2,645	125.437
	St-Dev	1.711	47,663	0.306	2.151	0.025	178,042	184	12.288
	Var	2.927	$2,271*10^6$	0.094	4.627	0.001	$31,698*10^6$	33,779	150.997

Appendix 2 : Unit Roots test.

Two tests for unit roots were performed, ADF2 and ADF3. Critical values are 2,89 and 3,40, respectively, and thus all variables are I(1) processes.

		ADF2			ADF 3		
	Variable	OLS	*t-stat*	p-value	OLS	*t-stat*	p-value
Northern	W_1	-0.2533	-2.1557	0.22000	-0.3843	-2.4351	0.36000
	W_2	-0.2276	-1.7278	0.41000	-0.4220	-2.1367	0.52000
	W_3	-0.2973	-2.0612	0.26000	-0.5428	-2.6452	0.26000
	P	-0.1233	-1.5020	0.53000	-0.2494	-1.9104	0.65000
	Q	0.0034	0.1119	0.97000	-0.2399	-2.1223	0.53000
	Y	-0.0999	-1.7254	0.41000	-0.2074	-2.5464	0.30000
	Z	-0.1191	-1.9713	0.30000	-0.1682	-1.9299	0.64000
Northeast	W_1	-0.3209	-1.9676	0.30000	-0.6716	-2.9774	0.14000
	W_2	-0.1944	-1.5152	0.52000	-0.3683	-1.9727	0.61000
	W_3	-0.2375	-1.7869	0.39000	-0.4619	-2.5225	0.31000
	P	-0.2205	-1.6519	0.45000	-0.6056	-3.0191	0.13000
	Q	-0.0887	-1.9077	0.33000	-0.2756	-3.461	0.04000
	Y	-0.0994	-1.6930	0.43000	-0.2008	-2.3917	0.38000
	Z	-0.1296	-1.8938	0.45000	-0.1825	-1.9669	0.49000
Southeast	W_1	-0.2026	-1.8911	0.34000	-0.3944	-2.7925	0.20000
	W_2	-0.1304	-1.4495	0.56000	-0.281	-2.2446	0.46000
	W_3	-0.175	-1.7034	0.42000	-0.356	-2.4637	0.34000
	P	-0.1599	-1.6961	0.43000	-0.3478	-2.5568	0.30000
	Q	-0.0645	-2.1884	0.21000	-0.0908	-1.7202	0.74000
	Y	-0.1014	-1.8401	0.36000	-0.2042	-2.6001	0.28000
	Z	-0.1941	-1.7356	0.36000	-0.1292	-1.9075	0.43000
Southern	W_1	-0.1912	-2.0479	0.27000	-0.3671	-2.9517	0.15000
	W_2	-0.1456	-1.6087	0.47000	-0.3172	-2.5115	0.32000
	W_3	-0.3109	-2.1122	0.24000	-0.5763	-2.8899	0.17000
	P	-0.1435	-1.8257	0.37000	-0.2893	-2.5725	0.29000
	Q	-0.1638	-1.0174	0.94000	-0.0641	-1.4851	0.54000
	Y	-0.2128	-2.5978	0.28000	-0.1064	-1.8532	0.35000
	Z	-0.1077	-1.9855	0.33000	-0.1223	-2.0293	0.39000
Midwest	W_1	-0.1739	-1.752	0.40000	-0.3504	-2.5927	0.28000
	W_2	-0.1925	-1.8631	0.35000	-0.3561	-2.567	0.30000
	W_3	-0.2375	-1.7869	0.39000	-0.4619	-2.5225	0.31000
	P	-0.2533	-1.7601	0.40000	-0.5409	-2.7759	0.21000
	Q	-0.0222	-0.4998	0.89000	-0.6513	-2.8217	0.19000
	Y	-0.0994	-1.6930	0.43000	-0.2008	-2.3917	0.38000
	Z	-0.2019	-1.7833	0.39000	-0.1722	-2.0105	0.57000

Appendix 3: Akaike (1989) test to determine the lag of each variable.

Variável	Northern		Northeast		Southeast		Southern		Midwest	
	Def.	*Stat.*	Def.	*Stat.*	Def.	*Stat.*	Def.	*Stat.*	Def.	*Stat.*
W_1	3	-3.16	2	-2.257	6	-1.74	5	-2.748	5	-2.629
W_2	6	0.382	2	0.813	5	1.138	3	0.233	2	0.979
W_3	2	-6.621	4	-7.243	4	-7.392	5	-8.837	3	-7.245
PZ	6	10.403	5	10.550	5	10.159	5	9.870	2	10.517
*Q**	1	-0.105	1	1.696	1	0.460	2	0.218	4	2.498
P	8	5.672	2	0.797	3	0.266	3	-0.229	3	0.876
Q	9	19.193	2	22.277	6	23.561	2	21.22	6	20.058
Y	1	22.8	1	22.84	1	0.46	2	-0.152	4	1.405
Z	6	3.744	8	10.498	5	10.159	5	9.87	1	10.439

Appendix 4: Johansen's cointegration test for the demand and supply relation.

Demand.

r	Northern	Northeast	Southeast	Southern	Midwest	Crit. value 5%
0	312.3	133.9	115.7	109.1	131.3	33.3
1	118.8	103.2	91.4	69.9	87.6	27.3
2	47.7	33.7	34.1	36.6	35.2	21.3
3	18.9	18.5	22.6	19.1	11.2	14.6
4	3.4*	6.2*	4.2*	6.8*	6.8*	12.1*

Supply Relation.

r	Northern	Northeast	Southeast	Southern	Midwest	Crit. value.5%
0	174.9	134.3	197.5	134.7	142	33.3
1	127.7	113.3	137.9	102.8	135.9	27.3
2	99.3	84.2	61.3	91.1	101.8	21.3
3	41.4	65.1	34.8	35.6	26.8	14.6
4	3.3*	10.3*	7.1*	9.9*	10.2*	12.1

Appendix 5: Separability Test.

Northern	Northeast	Southeast	Southern	Midwest	Crit.. value.5%
278.52	49.06	73.74	68.93	81.93	9.49